CADTH

CADTH RAPID RESPONSE REPORT:
SUMMARY WITH CRITICAL APPRAISAL

Room Service Food Delivery Models for Hospital In-Patients: A Review of Clinical Effectiveness, Cost-Effectiveness, and Guidelines

Service Line:	Rapid Response Service
Version:	1.0
Publication Date:	June 17, 2019
Report Length:	37 Pages

CADTH

Authors: Calvin Young, Kelly Farrah

Cite As: Room Service Food Delivery Models for Hospital In-Patients: A Review of Clinical Effectiveness, Cost-Effectiveness, and Guidelines. Ottawa: CADTH; 2019 June. (CADTH rapid response report: summary with critical appraisal).

ISSN: 1922-8147 (online)

About CADTH: CADTH is an independent, not-for-profit organization responsible for providing Canada's health care decision-makers with objective evidence to help make informed decisions about the optimal use of drugs, medical devices, diagnostics, and procedures in our health care system.

Funding: CADTH receives funding from Canada's federal, provincial, and territorial governments, with the exception of Quebec.

Questions or requests for information about this report can be directed to Requests@CADTH.ca

Abbreviations

AMSTAR II	A Measurement Tool to Assess Systematic Reviews 2
BMI	body mass index
CRD	Centre for Reviews and Dissemination
MeSH	Medical Subject Headings
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	randomized controlled trial

Context and Policy Issues

Hospital food services play a critical role in the management of all hospitalized patients. Optimal nutritional intake is considered crucial for both patient health and patient satisfaction with their hospital experience.[1,2] Inadequate food intake throughout the course of admission may result in nutritional status deterioration,[3] which is associated with prolonged length of stay, decreased quality of life, and increased morbidity and mortality.[4-6] The prevalence of malnutrition in Canadian hospitals has been estimated to be as high as 45%,[7] an issue which is the source of significant financial burden to health systems.[8] In addition to the economic considerations, there is increasing focus on the importance of patient-centred and value-based health care within the Canadian system,[9] approaches in which food service models may be central factors.

Numerous strategies have been implemented to source, purchase, prepare, and deliver food within hospital settings both nationally and internationally, with no truly standardized approaches established. Some examples of these strategies include: restaurant style menus, on-demand dining, paper menus, meals served at a buffet service, communal dining halls, spoken menus or other electronic ordering systems, meal cart delivery service, cook-chill systems, high frequency meals, and traditional meal service models that typically consist of three meals per day served at the patient bedside.[10] Understanding the differences between these service models and their possible benefits compared to each other is potentially valuable information for decision-makers who are responsible for the planning of food service models within their hospital facilities or jurisdictions.

The purpose of the current report is to evaluate the clinical effectiveness, cost-effectiveness, and evidence-based guidelines regarding alternative room service food delivery models for hospital in-patients. The findings of this review are supplemented by a qualitative review[11] of patient preferences and perspectives on the same topic, separately conducted by CADTH.

Research Questions

1. What is the clinical effectiveness of alternative room service food delivery models for hospital in-patients?
2. What is the cost-effectiveness of alternative room service food delivery models for hospital in-patients?
3. What are the evidence-based guidelines on alternative room service food delivery models for hospital in-patients?

Key Findings

One relevant systematic review and nine non-randomized studies were identified regarding the clinical effectiveness of alternative room service food delivery models for hospital in-patients. The included trial designs, interventions, comparators, and characteristics of patients examined in these studies were highly heterogeneous.

Evidence of limited quality demonstrated that food delivery models that provided patients with increased flexibility in meal options and timing of meal delivery generally improved the nutritional intake of hospital in-patients. Despite this, there was no literature identified that suggested these increases in nutritional intake translated to decreased hospital length of stay. It was unclear which specific food delivery models may be most beneficial to in-patients (e.g., pre-plated service, communal dining halls, spoken menus or other electronic ordering systems, chilled kitchens, steamplicity systems, or on-demand dining).

No evidence regarding the cost-effectiveness of alternative room service food delivery models for hospital in-patients was identified. Additionally, no evidence-based guidelines were identified.

The limitations of the included studies (e.g., their open-label nature, the severe risk of bias due to confounding, and the limited literature from Canadian settings) and of this report should be considered when interpreting the results.

Methods

Literature Search Methods

A limited literature search was conducted by an information specialist on key resources including MEDLINE, the Cochrane Library, the University of York Centre for Reviews and Dissemination (CRD) databases, the websites of Canadian and major international health technology agencies, as well as a focused Internet search. The search strategy was comprised of both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. The main search concepts were food service models and hospitals. No filters were applied to limit the retrieval by study type. The search was also limited to English language documents published between January 1, 2014 and May 17, 2019.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria

Population	Hospital in-patients
Intervention	Alternative room service food delivery models in hospital (i.e., restaurant style menu, on demand dining, room service)
Comparator	Q1-2: Traditional food service delivery model (e.g., conventional hot serve, cold plating, outsourced) Q3: No comparator

Outcomes	Q1: Clinical effectiveness (e.g., length of stay, food intake, change in health status, change in nutrition status) Q2: Cost-effectiveness (e.g., incremental cost per quality adjusted life year or health benefit) Q3: Evidence-based guidelines
Study Designs	Health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies, economic evaluations, and evidence-based guidelines

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, or were published prior to 2014. Systematic reviews that had broader inclusion criteria than the present review were examined in detail to ascertain whether data could be extracted from a relevant sub-set of included studies, rather than excluding the systematic review entirely. If it was not possible to identify relevant primary studies upon detailed investigation the systematic review was excluded. Primary studies retrieved by the search were excluded if they were captured in one or more included systematic reviews. Studies that examined food delivery services in mixed populations (e.g., staff and patient populations with no analysis specific to patients) or only examined qualitative outcomes or outcomes relating to food wastage were excluded. Qualitative studies are reviewed in a separate CADTH Rapid Response report.[11] Finally, guidelines with unclear methodology were also excluded.

Critical Appraisal of Individual Studies

The included systematic reviews and clinical studies were critically appraised by one reviewer using AMSTAR II[12] and the Downs and Black checklist,[13] respectively. Summary scores were not calculated for the included studies; rather, a review of the strengths and limitations of each included study were described narratively.

Summary of Evidence

Quantity of Research Available

A total of 415 citations were identified in the literature search. Following screening of titles and abstracts, 392 citations were excluded and 23 potentially relevant reports from the electronic search were retrieved for full-text review. In addition, three potentially relevant publications were retrieved from the grey literature search for full-text review. Of these 26 potentially relevant articles, 16 publications were excluded for various reasons, while 10 publications met the inclusion criteria and were included in this report. These comprised one systematic review[10] and nine non-randomized studies.[14-22] Appendix 1 presents the PRISMA[23] flowchart of the study selection. Additional references of potential interest are provided in Appendix 5.

Summary of Study Characteristics

One systematic review[10] and nine non-randomized studies[14-22] were identified and included in this review. No relevant health technology assessments, meta-analyses, randomized controlled trials, economic evaluations, or evidence-based guidelines were identified. Detailed characteristics are available in Appendix 2, Table 3: and Table 4.

Study Design

The identified systematic review[10] had objectives and inclusion criteria that were broader than the present report (i.e., wider in scope). Of the 33 primary studies it reviewed, ten studies[24-33] were relevant under our inclusion criteria. Only information from the subset of relevant studies is included here. Authors of the systematic review,[10] published in 2019, searched for randomized controlled trials (RCTs), cohort studies, and cross-sectional studies in PubMed, Embase, the Cochrane Library, and the Web of Science up to December 2, 2017. Three of the relevant primary studies were classified as pre-post prospective cohorts,[24,25,27] five as prospective cohorts,[26,28-30,33] one as a retrospective cohort,[31] and one as a single-blinded RCT.[32] These relevant primary studies were published between 2000 and 2017.[24-33]

Nine additional primary studies[14-22] regarding the clinical effectiveness of alternative room service food delivery models for hospital in-patients were identified. These studies[14-22] were all non-randomized using various methodologies: four pre-post cohort studies,[14,17,18,22] one observational point prevalence cohort study,[15] one post-hoc analysis of data collected from a pre-post cohort study,[16] two cross-sectional cohort studies,[19,20] and one observational crossover study.[21]

Country of Origin

The included systematic review was by authors in the Netherlands.[10] The countries of origin for the included primary studies[24-33] were not summarized in the systematic review.

The non-randomized studies were conducted in Australia,[15,17-19,21,22] India,[14] the Netherlands,[16] and Spain.[20]

Patient Population

The systematic review[10] included studies that enrolled adult hospitalized patients who received various food service interventions. Studies that took place in nonhospital facilities (e.g., nursing homes, rest homes, and assisted-living facilities) were excluded. Patient characteristics varied by primary study; however, mean ages of patient cohorts generally ranged between 65 and 80 years. A total of 2,694 participants were included in the relevant studies, with individual studies recruiting between 52 and 969 participants.

The nine non-randomized studies[14-22] recruited hospital in-patients from various settings. Two studies recruited patients from oncology wards[14,15] while the remaining seven studies[16-22] did not recruit a specific type of hospitalized patient. All nine studies[14-22] appeared to only consider adult patients aged ≥ 18 years of age, although this inclusion criterion was clearly distinguished in six studies.[14-18,20] Exclusion criteria for these studies varied; however, patients who were critically ill, nil by mouth, or who were on enteral feeding or parenteral nutrition were typically excluded. A total of 1,798 participants were included in the non-randomized studies,[14-22] with individual studies including between 30 and 637 participants.

Interventions and Comparators

The systematic review by Dijxhoorn et al.[10] included studies that compared a wide variety of food service interventions to alternative or traditional food service interventions. A summary of the interventions and comparators used in relevant primary studies, as described in the systematic review,[10] is provided in Table 2.

Table 2: Interventions and Comparators used in Relevant Primary Studies from the Dijxhoorn et al.[10] Systematic Review

Primary Study Citation	Study Design	Intervention(s)	Comparator(s)
Dijxhoorn, 2017[24] (N = 637)	Pre-post prospective cohort	"FoodforCare meal service" that included 6 small protein-rich menu items. Nutritional assistants provided recommendations to patients in choosing the most optimal menu item.	Traditional meal services that consisted of 3 meals per day served by nutritional assistants. Patients selected their dinner preferences in the morning using a menu.
Doorduijn, 2015[25] (N = 337)	Pre-post prospective cohort	Patients were able to order food and drinks throughout the day (between 7:00 am and 7:00 pm) using a telephone and printed menu. Food was delivered within 45 minutes of order.	Traditional meal service that consisted of 3 meals per day with drink between meals. Patients selected their meals a day prior to receiving them.
Edwards, 2006[26] (N = 52)	Prospective cohort	"Steamplicity system" where patients ordered their meals 2 hours in advance from an extended choice menu. Individual plated meals were transported to the ward, held chilled, and heated in the microwave prior to serving.	"Cook-chill system" where a cyclical menu was given to patients to order their food a day in advance. Cold bulk food was loaded into a trolley and transported to the ward. Food was regenerated immediately prior to serving.
Freil, 2006[27] (N = 969)	Pre-post prospective cohort	An individual meal system that gave patients a choice of energy enriched meals from a menu cart. A second intervention group consisted of the same individualized system two years after its implementation.	Traditional meal service that provided patients with a fixed menu with no possibility of individualization.
Goeminne, 2012[28] (N = 189)	Prospective cohort	Patients were given a choice of meal type and portion size from a food cart at mealtime.	Traditional system where patients ordered meals 1 day in advance.
Hickson, 2007[29] (N = 57)	Prospective cohort	"Steamplicity system" where patients ordered their meals 2 hours in advance from an extended choice menu. Individual plated meals were transported to the ward, held chilled, and heated in the microwave prior to serving.	"Cook-chill system" where a printed menu was filled in by patients in advance of meal delivery (timeframe was not specified). Meals were transported to wards and regenerated in bulk prior to serving.
Larsen, 2007[30] (N = 113)	Prospective cohort	Patients ordered food by phone using an à la carte style menu up to 24 hours in advance at any point in the day. Meals were delivered within 45 minutes.	Traditional meal service that provided patients with a fixed menu of 3 meals per day at set times.
McCray, 2017[31] (N = 148)	Retrospective cohort	Patients were able to order meals by phone using an à la carte style menu throughout the day (between 6:30 am and 7:00 pm). Food was delivered within 45 minutes of order.	Traditional food service model where patients ordered meals with a paper menu up to 24 hours before the meal. Meals were delivered at set times.
Munk, 2014[32] (N = 84)	Single-blinded RCT	The standard hospital menu was supplemented with the option to order energy enriched food off an à la carte style menu. Food was delivered within 20 minutes of ordering.	Standard hospital menu that included 3 main meals served from a buffet and 3 in-between meals served by nursing or buffet staff.

Primary Study Citation	Study Design	Intervention(s)	Comparator(s)
Wilson, 2000[33] (N = 108)	Prospective cohort	"Bulk service" where printed menus were filled in by patients at wards and bulk supply was estimated accordingly. Food was plated from a hostess trolley and patients were given the option to change their selection at point of service.	Printed menus were filled in by patients at wards. Meals were plated and transported to patients directly. Patients were not given the opportunity to change their meal selection at the point of service.

N = number of patients; RCT = randomized controlled trial.

The nine non-randomized studies[14-22] examined a variety of food delivery models compared to alternative or more traditional meal delivery services in hospitals. The investigated interventions included à la carte style menus that provided patients with increased choice,[14,17] a "FoodforCare" meal service that included six meals per day,[16] a central pre-plated service,[19] a bedside electronic meal ordering system,[15] a bedside spoken meal ordering system,[18,22] a chilled kitchen system,[20] and the "Dining with Friends" program.[21] These were compared with traditional food service models where patients were typically served three meals a day ordered through paper menus,[14-18,22] bistro meal serice,[19] meals prepared in a traditional kitchen,[20] and meals served at the patient bedside.[21]

Outcomes

The relevant outcomes considered in the systematic review[10] were nutritional intake, food intake, length of stay, and other functional outcomes (e.g., handgrip strength).

The outcomes of interest in the non-randomized studies[14-22] were largely relating to nutritional intake, although one non-randomized[14] study examined in-hospital weight change while another[15] considered hospital length of stay.

Nutritional intake was typically measured by estimating the amount of food consumed using a five-point visual wastage scale (0%, 25%, 50%, 75% and 100% wasted). The dietary intake observation would then be converted to nutritional intake values based on known food composition for each specific meal. The exact methods varied by individual study and were often not well-described.

Data from outcomes of a qualitative nature (e.g., patients' and families' experiences or satisfaction) were not extracted from the included studies as they did not meet the inclusion criteria. These outcomes are discussed in a separate Rapid Qualitative Review.[11]

Summary of Critical Appraisal

Additional details regarding the strengths and limitations of the included publications are provided in Appendix 3, Table 5 and Table 6.

Systematic Reviews

A number of strengths of the included systematic review[10] were identified through the critical appraisal process. The research question, objectives, and eligibility criteria were clearly described. Key search terms were provided and literature searches were performed in multiple databases. The methods for article selection, data extraction, and quality assessment were well-documented and all three were conducted in duplicate, decreasing the likelihood for inconsistency in these processes. The review included a flow chart

illustrating study selection and provided reasons for articles excluded after full-text review. These strengths of reporting increase confidence in the findings and the reproducibility of the systematic review. Finally, the review authors stated that they had no conflicts of interested related to this review and that they received no funding related to this work.

Several limitations of the included systematic review[10] were identified. To start, it was unclear if the review methods were established were established a priori as there was no reference to a study protocol. In addition, the literature searching did not include a grey literature search, increasing the risk for missing relevant, non-indexed studies, and although reasons for exclusion were provided, the review did not include a list of the excluded studies, Finally, there was no discussion of publication bias and the countries in which relevant primary studies were conducted was not described; therefore the generalizability of the findings to the Canadian setting is unclear.

Non-Randomized Studies

There were several strengths common to all nine non-randomized studies,[14-22] such as clearly described objectives, interventions, controls, main outcomes, eligibility criteria, and population characteristics. Although study designs and data sources were variable between studies, all publications[14-22] sufficiently described the methods for data collection. The main outcomes were considered accurate and compliance with the intervention was reliable (as quantified by measures of food provision and wastage) in all nine non-randomized studies.[14-22] Baseline patient characteristics were tested for statistically significant differences between treatment groups; however, these characteristics were largely limited to age, sex, and in some cases body weight or body mass index (BMI). Additional patient characteristics, such as malnutrition scores, reason for hospitalization, or socioeconomic indicators, would have been helpful to gauge the level of balance between cohorts (estimating the risk of confounding). All included non-randomized studies[14-22] were open-label, increasing the risk for bias in either direction depending on the perceptions and expectations of participants and outcome assessors. Six studies[14-18,22] were conducted as pre-post cohort studies that measured patient outcomes before and after the implementation of a novel food service model at a hospital. These studies[14-18,22] are at increased risk for bias due to their lack of adjustment for potentially confounding variables between patient groups recruited often years apart from one another.

Study participants, care providers, and health care settings appeared to be representative of the "real-world" in all non-randomized studies, increasing their external validity. However, five studies were conducted at single centres in Australia[15,17,18,22] or the Netherlands,[16] and the generalizability of the findings to other centres or countries is not clear. A further limitation of some studies was that sources of funding were either not disclosed[19] or disclosed and included funding received from groups that have ties to the intervention under investigation.[16] Similarly, some study authors disclosed conflicts of interest which may have influenced the findings of the study.[17,18,22]

Summary of Findings

The overall findings of the included studies are summarized below. A detailed summary of the main findings is available in Appendix 4, Table 7 and Table 8.

Clinical Effectiveness of Alternative Room Service Food Delivery Models

Nutritional Intake

Evidence regarding the clinical effectiveness of alternative room service delivery with respect to various nutritional outcomes was available from 10 primary studies[24-33] included in the systematic review[10] and nine non-randomized studies.[14-22] Due to the large volume of evidence on this outcome and the heterogeneity in interventions and comparators these results will be summarized by intervention.

Two studies[16,24] investigated the effectiveness of the "FoodforCare" meal service that included six protein-rich meals per day (three main meals and three in-between meals) compared to a traditional meal service of three meals per day. Both studies reported significant increases in energy or protein intake for patients in the "FoodforCare" group. The first study[24] observed a significantly higher energy and protein intake relative to daily requirements on day 1 and day 4 (i.e., patients had a higher mean intake relative to their recommended intake in the "FoodforCare" group). In addition, patients in the "FoodforCare" group were more likely to fulfill their daily protein and energy requirements. The second study[16] reported that the "FoodforCare" cohort demonstrated a significantly higher median protein intake for each meal of the day, with the exception of the 5:00 pm meal where there were no significant between-group differences. It should be noted that these studies were both from the same population; the second study[16] was a post-hoc analysis of data collected from the first study.[24]

Six studies[14,17,25,30-32] compared various à la carte room service models (that provided increased choice or access to patients) versus more traditional meal services (typically consisting of three meals per day). Three of these studies[14,17,31] observed significantly increased mean energy intake and mean protein intake in the room service cohort compared to patients in the traditional meal service cohort. The study by Larsen et al.[30] reported that patients in the à la carte cohort had significantly increased mean fat intake and a higher proportion met their daily energy requirements compared to those in the traditional meal service cohort; however, patients in the traditional cohort had significantly increased mean carbohydrate intake and there were no significant between-group differences in mean energy intake. The results of the Munk et al.[32] study indicated that patients in the room service cohort had significantly higher mean daily protein intake, but there were no significant differences in mean daily energy intake compared to the traditional meals service cohort. Finally, one study[25] reported no significant differences in energy and protein intake between patients in the room service and traditional service cohorts.

Three studies[27,28,33] compared various meal delivery systems using meal carts compared with more traditional meal service systems. The study by Freil et al.,[27] where the authors performed analysis by quartile of energy intake within each meal delivery service group, noted significant increases in energy intake and protein intake in the first quartile of patients (i.e., lowest energy intake) served using a menu cart compared to those served with a traditional meal system without the possibility of individualizing meal selection. The results of the second study[28] indicated that the meals on wheels system significantly increased daily nutrient intake compared to those served with the standard system. The third study,[33] which compared patient cohorts served with a bulk service on meal carts versus a traditional plated system, reported significantly increased daily energy intake, protein intake, fat intake, and carbohydrate intake in the bulk service cohort.

Two studies[26,29] investigated the effectiveness of a steamplicity system versus a cook-chill system. The first study[26] observed increased nutrient intake at lunch and dinner in patients served using the steamplicity system compared to those served using a cook-chill system. Conversely, the second study[29] reported significantly increased food consumption and energy intake in patients served with the cook-chill system compared to those served with the steamplicity system. There were no significant between-group differences in protein intake.[29]

One study[15] compared nutritional outcomes in patients served using a bedside electronic meal ordering system versus patients who placed their meal orders using traditional paper menus. Patients in the bedside electronic meal ordering system group demonstrated significantly increased mean energy intake and protein intake relative to patients in the paper menu cohort.

One study[19] evaluated a central pre-plated meal service versus a bistro meal service for in-patients eating their dinner meal in the ward dining room. The findings indicated that there were no significant differences in mean energy intake or mean protein intake between intervention cohorts.

Two studies[18,22] investigated a bedside spoken meal ordering system compared to a traditional paper menu system. Both of these studies[18,22] observed significantly increased mean energy intake and mean protein intake in the spoken meal ordering system cohort compared to the traditional menu system.

One study[20] compared patient cohorts served using a chill kitchen system or a traditional kitchen system. The findings demonstrated that patients in the chilled kitchen cohort had significantly higher mean daily energy intake and mean daily protein intake; however, when these were adjusted by patient weight (i.e., the mean daily energy or protein intake per patient weight) the findings were no longer significant.

One study[21] compared nutritional outcomes in patients when they were served their midday meal in a communal dining room (the “Dining with Friends” program) versus at their bedside. There were significant increases in mean energy intake and mean protein intake when patients were served in a communal dining hall.

Handgrip Strength

Information regarding the clinical effectiveness of alternative room service food delivery models for handgrip strength was available from two primary studies[25,32] included in the systematic review.[10] These two studies compared room service models that allowed patients to order food off an à la carte style menu (allowing for more flexibility in the timing of food delivery) versus more traditional meal service models where patients were served three main meals per day. Both studies found no significant differences in handgrip strength between their treatment cohorts.

Body Weight

Mean in-hospital weight change experienced by patients was examined in one non-randomized study.[14] The results of this study indicated that oncology patients who were served using a patient-centered food service model increased their body weight by a mean of 0.18 kg while hospitalized. This compared to a mean loss of 0.58 kg in the cohort of patients served using a traditional food service model. These differences were statistically significant ($P < 0.01$).

Length of Hospital Stay

Evidence regarding the clinical effectiveness of alternative room service food delivery models with respect to length of hospital stay was available from one primary study[32] included in the systematic review[10] and one non-randomized study.[15] The first study[32] compared patients who had access to energy enriched foods off of an à la carte style menu in addition to a standard hospital menu that included three main meals per day versus standard hospital service alone. The second study[15] compared a service model that utilized a bedside electronic meal ordering system versus a traditional model with paper menus. Neither study[15,32] reported a significant difference in length of hospital stay between treatment groups.

Cost-Effectiveness of Alternative Room Service Food Delivery Models

No relevant evidence regarding the cost-effectiveness of alternative room service food delivery models for hospital in-patients was identified; therefore, no summary can be provided.

Evidence-Based Guidelines on Alternative Room Service Food Delivery Models

No evidence-based guidelines regarding alternative room service food delivery models for hospital in-patients were identified; therefore, no summary can be provided.

Limitations

A number of limitations were identified in the critical appraisal (Appendix 4, Table 7: and

Table 8:), however, additional limitations exist.

There was notable heterogeneity between included studies with respect to trial design, interventions, comparators, and patients' characteristics. For example, data on a majority of specific food service interventions were from a single trial. Although a relatively large number of relevant primary studies were identified, the evidence for any single intervention was fairly limited.

The interventions under investigation were often inadequately defined to gain a true understanding of what patients were provided with under various treatment arms. Several factors that were not described, such as the level of support provided by care providers or staff while patients ate their meals, a clear description of menu items, and the nutrient composition of meals, may play an important role in the observed treatment effects.

A potentially major limitation that should be considered when interpreting these results is that participants and outcome assessors were aware of treatment allocation in all reviewed studies.[10,14-22,24-33] This increases the risk for bias in either direction depending on the perceptions and expectations of those involved, potentially having an effect on the reliability of the results.

As outlined in the inclusion criteria, studies that assessed outcomes relating to implementation issues, patients' and families' experiences with alternative food service (e.g., satisfaction, sense of health or well-being), or other qualitative outcomes were not included in this report. The findings of these studies are summarized in a separate qualitative review.[11]

No evidence regarding the cost-effectiveness of alternative room service food delivery models for hospital in-patients was identified. Additionally, no evidence-based guidelines were identified.

The applicability of the evidence to Canadian settings is unclear as the country of origin of included studies was either not available[24-33] or they were conducted outside of North America.[14-22] Evaluating the relevance of the results to the Canadian context requires an assessment of the differences in the delivery of health care services in Canada and the other countries included in this report (i.e., Australia,[15,17-19,21,22] India,[14] the Netherlands,[16] and Spain[20]).

Conclusions and Implications for Decision or Policy Making

This review was comprised of one systematic review[10] and nine non-randomized studies[14-22] regarding the clinical effectiveness of alternative room service food delivery models for hospital in-patients. No evidence was identified for the cost-effectiveness of alternative room service food delivery models for hospital in-patients. Additionally, no evidence-based guidelines were identified.

The findings of the identified literature[10,14-22] generally provided support for food service interventions that gave patients increased flexibility in the timing of meal delivery and increased choice in menu options. There was considerable evidence[14-18,21,22,24,26-28,30-33] that demonstrated statistically significant improvements in outcomes relating to nutritional intake (e.g., energy intake, protein intake) for patients who received meals through several alternative food service interventions compared to more traditional food service models. No studies demonstrated significant differences in mean hospital length of stay between intervention groups.

The reviewed food service interventions were highly heterogeneous, and although several intervention characteristics (e.g., increased meal choice, flexibility in when meals were ordered and served) appeared to impact patient nutritional outcomes, it was unclear which systems may be most beneficial to patients. Additionally, patient characteristics such as age, sex, BMI, nutritional status, and reason for hospitalization may have had an unknown effect on relevant outcomes.

The limitations of the included studies and of this report should be considered when interpreting the results. The findings highlighted in this review come with a high degree of uncertainty due to the heterogeneity of investigated interventions and the high risk of bias due to confounding from individual studies. Further research investigating the clinical and cost-effectiveness of alternative room service food delivery models for hospital in-patients, especially through the use of large, methodologically-sound RCTs, would help reduce this uncertainty.

References

1. Wall BT, van Loon LJ. Nutritional strategies to attenuate muscle disuse atrophy. *Nutr Rev.* 2013;71(4):195-208.
2. Dall'Oglio I, Nicolo R, Di Ciommo V, et al. A systematic review of hospital foodservice patient satisfaction studies. *J Acad Nutr Diet.* 2015;115(4):567-584.
3. Valla FV, Baudin F, Gaillard Le Roux B, et al. Nutritional status deterioration occurs frequently during children's ICU stay. *Pediatr Crit Care Med.* 2019 May 31. [Epub ahead of print].
4. Allard JP, Keller H, Jeejeebhoy KN, et al. Decline in nutritional status is associated with prolonged length of stay in hospitalized patients admitted for 7 days or more: A prospective cohort study. *Clin Nutr.* 2016;35(1):144-152.
5. Kyle UG, Genton L, Pichard C. Hospital length of stay and nutritional status. *Curr Opin Clin Nutr Metab Care.* 2005;8(4):397-402.
6. Stratton RJ, King CL, Stroud MA, Jackson AA, Elia M. 'Malnutrition Universal Screening Tool' predicts mortality and length of hospital stay in acutely ill elderly. *Br J Nutr.* 2006;95(2):325-330.
7. Laur C, McCullough J, Davidson B, Keller H. Becoming food aware in hospital: a narrative review to advance the culture of nutrition care in hospitals. *Healthcare (Basel).* 2015;3(2):393-407.
8. Curtis LJ, Bernier P, Jeejeebhoy K, et al. Costs of hospital malnutrition. *Clin Nutr.* 2017;36(5):1391-1396.
9. Murphy T. The role of food in hospitals. HealthCareCAN; 2017: http://www.healthcarecan.ca/wp-content/themes/camyno/assets/document/Reports/2017/HCC/EN/RoleofFood_FinalEN.pdf. Accessed 2019 Jun 17.
10. Dijxhoorn DN, Mortier M, van den Berg MGA, Wanten GJA. The currently available literature on inpatient foodservices: systematic review and critical appraisal. *J Acad Nutr Diet.* 2019;25:25.
11. Room service food delivery models for hospital in-patients: a rapid qualitative review [project in progress]. *(CADTH Rapid response report: summary with critical appraisal)*. Ottawa (ON): CADTH; 2019: https://clots.cadth.ca/room-service-food-delivery-models-hospital-patients-rapid-qualitative-review. Accessed 2019 May 22.
12. Shea BJ, Reeves BC, Wells G, et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ.* 2017;358:j4008. http://www.bmj.com/content/bmj/358/bmj.j4008.full.pdf. Accessed 2019 Jun 17.
13. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health.* 1998;52(6):377-384. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1756728/pdf/v052p00377.pdf. Accessed 2019 Jun 17.
14. Sathiaraj E, Priya K, Chakraborthy S, Rajagopal R. Patient-centered foodservice model improves body weight, nutritional intake and patient satisfaction in patients undergoing cancer treatment. *Nutr Cancer.* 2019;71(3):418-423.
15. Barrington V, Maunder K, Kelaart A. Engaging the patient: improving dietary intake and meal experience through bedside terminal meal ordering for oncology patients. *J Hum Nutr Diet.* 2018;31(6):803-809.
16. Dijxhoorn DN, IJmker-Hemink VE, Wanten GJA, van den Berg MGA. Strategies to increase protein intake at mealtimes through a novel high-frequency food service in hospitalized patients. *Eur J Clin Nutr.* 2018;22:22.
17. McCray S, Maunder K, Barsha L, Mackenzie-Shalders K. Room service in a public hospital improves nutritional intake and increases patient satisfaction while decreasing food waste and cost. *J Hum Nutr Diet.* 2018;31(6):734-741.
18. McCray S, Maunder K, Norris R, Moir J, MacKenzie-Shalders K. Bedside Menu Ordering System increases energy and protein intake while decreasing plate waste and food costs in hospital patients. *Clin Nutr ESPEN.* 2018;26:66-71.
19. Young AM, de Jersey SJ, Ellick J, Lewis CA, Banks M. Comparison of patient food intake, satisfaction and meal quality between two meal service styles in a geriatric inpatient unit. *J Nutr Gerontol Geriatr.* 2018;37(3-4):158-168.
20. Calleja-Fernandez A, Velasco-Gimeno C, Vidal-Casariego A, et al. Impact of kitchen organization on oral intake of malnourished inpatients: A two-center study. *Endocrinol.* 2017;64(8):409-416.
21. Markovski K, Nenov A, Ottaway A, Skinner E. Does eating environment have an impact on the protein and energy intake in the hospitalised elderly? *Nutr Diet.* 2017;74(3):224-228.
22. Maunder K, Lazarus C, Walton K, Williams P, Ferguson M, Beck E. Energy and protein intake increases with an electronic bedside spoken meal ordering system compared to a paper menu in hospital patients. *Clin Nutr ESPEN.* 2015;10(4):e134-e139.
23. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol.* 2009;62(10):e1-e34.
24. Dijxhoorn DN, van den Berg MGA, Kievit W, Korzilius J, Drenth JPH, Wanten GJA. A novel in-hospital meal service improves protein and energy intake. *Clin Nutr.* 2018;37(6 Pt A):2238-2245.
25. Doorduijn AS, van Gameren Y, Vasse E, de Roos NM. At Your Request(®) room service dining improves patient satisfaction, maintains nutritional status, and offers opportunities to improve intake. *Clin Nutr.* 2016;35(5):1174-1180.

26. Edwards JSA, Hartwell HJ. Hospital food service: a comparative analysis of systems and introducing the 'Steamplicity' concept. *J Hum Nutr Diet.* 2006;19(6):421-430.

27. Freil M, Nielsen MA, Biltz C, Gut R, Mikkelsen BE, Almdal T. Reorganization of a hospital catering system increases food intake in patients with inadequate intake. *Scand J Food Nutr.* 2006;50(2):83-88.

28. Goeminne PC, De Wit EH, Burtin C, Valcke Y. Higher food intake and appreciation with a new food delivery system in a Belgian hospital. Meals on Wheels, a bedside meal approach: A prospective cohort trial. *Appetite.* 2012;59(1):108-116.

29. Hickson M, Fearnley L, Thomas J, Evans S. Does a new steam meal catering system meet patient requirements in hospital? *J Hum Nutr Diet.* 2007;20(5):476-485.

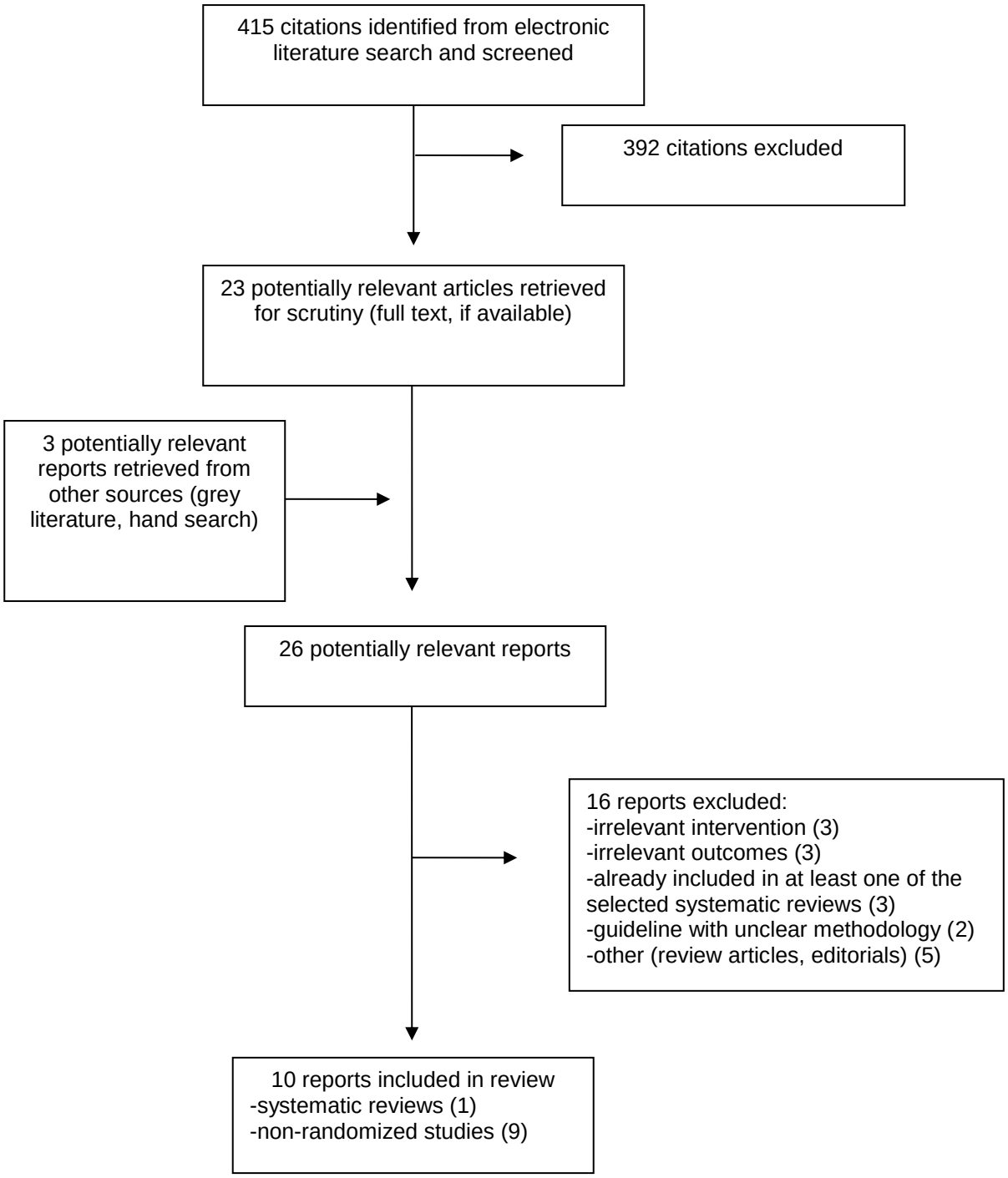
30. Larsen CS, Toubro S. The effect of conventional v. à la carte menu on energy and macronutrient intake among hospitalized cardiology patients. *Br J Nutr.* 2007;98(2):351-357.

31. McCray S, Maunder K, Krikowa R, MacKenzie-Shalders K. Room service improves nutritional intake and increases patient satisfaction while decreasing food waste and cost. *J Acad Nutr Diet.* 2018;118(2):284-293.

32. Munk T, Beck AM, Holst M, et al. Positive effect of protein-supplemented hospital food on protein intake in patients at nutritional risk: a randomised controlled trial. *J Hum Nutr Diet.* 2014;27(2):122-132.

33. Wilson A, Evans S, Frost G. A comparison of the amount of food served and consumed according to meal service system. *J Hum Nutr Diet.* 2000;13(4):271-275.

Appendix 1: Selection of Included Studies



Appendix 2: Characteristics of Included Publications

Table 3: Characteristics of the Included Systematic Review

First Author, Publication Year, Country	Study Designs, Search Strategy, Numbers of Studies Included, Quality Assessment Tool, Objective	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
Dijxhoorn, 2019[10] Netherlands	**Study design**: SR of relevant RCTs, cohort studies, and cross-sectional studies **Literature search strategy**: Authors performed literature searches in PubMed, Embase, the Cochrane Library, and the Web of Science up to December 2, 2017. Medical subject heading terms included food service, hospital, menu planning, and hospitalization. There were no restrictions on language or date of publication. **Number of studies included**: In total, 33 studies were included, with 10 studies[24-33] relevant for this review **Quality assessment tool**: Quality assessment was performed using Quality Criteria Checklist for Primary Research (QCCPR) **Objective**: To assess the effectiveness of various food service interventions on nutrition, clinical, and patient-reported outcomes	Adult hospitalized patients. Studies on patients who received parenteral and/or tube feeding or that took place in nonhospital facilities (e.g., nursing homes, rest homes, and assisted-living facilities) were excluded.	**Interventions**: Various food service interventions, including: preparation and composition of meals, menu, meal delivery, mealtime assistance, or mealtime environment **Comparators**: Other or more traditional food service interventions Studies relevant to the present report compared various food delivery interventions, including 6 meal per day service, on-demand room service, à la carte menus, allowing patients to choose their meal shortly before time of consumption, and several other alternative methods of food delivery to traditional meal service.	**Relevant Outcomes**: - Nutritional intake - Food intake - Nutritional status - Length of stay - Handgrip strength **Follow-up**: NR; varied by individual study Note: the SR was not limited to these outcomes. For example, multiple studies looked at outcomes relating to patient satisfaction.

NR = not reported; QCCPR = Quality Criteria Checklist for Primary Research; RCT = randomized controlled trial; SR = systematic review.

Table 4: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
Sathiaraj, 2019[14] India	**Study design**: Retrospective, pre-post cohort study **Setting**: Data from patients hospitalized at Cytecare Hospitals in Bengaluru, India, were collected between September 2017 and March 2018 as a patient-centered food service model was adopted **Objective**: To evaluate patient satisfaction and nutritional intake with a patient-centered foodservice model in a cancer hospital	**Inclusion criteria**: Adult hospitalized oncology patients who received food service **Excluded**: Patients who were critically ill, palliative, nil by mouth, restricted to fluid consumption, on enteral tube feeding or parenteral nutrition, or without 24 hours of consecutive nutritional intake data **Number of patients:** 160 (100 in the patient-centered group; 60 in the traditional group) **Mean age, years (SD)**: 55.13 (17.39) in the patient-centered group; 55.13 (17.00) in the traditional group **Sex**: 51.1% female in the patient-centered group; 51.7% female in the traditional group **Mean weight, kg (SD)**: NR	**Intervention**: Patient-centered food service model. This model gave patients and/or their family the option of ordering meals from an à la carte style menu throughout the day (including midnight snacks) **Comparator**: Traditional food service model. Patients were served meals off a seven-day cyclic menu at set timings during the day meals (breakfast: 8:00 am to 9:00 am; lunch: 11:45 am to 12:45 pm; dinner: 7:00 pm and 8:00 pm)	**Relevant Outcomes:** - Nutritional intake - Weight change - Food intake
Barrington, 2018[15] Australia	**Study design**: Single-centre, observational point prevalence cohort study **Setting**: Data was collected at two time points (April 2015 and October 2016) before and after a 96-bed oncology hospital in Melbourne, Australia, transitioned to a BEMOS	**Inclusion criteria**: Oncology in-patients (≥ 18 years of age) admitted during the 2 weeks of data collection periods (April 2015 and October 2016) **Excluded**: Patients who were consuming less than three hospital provided main meals per day, younger than 18, on clear or free fluid, nil by mouth, on enteral tube feeding or parenteral nutrition, or were receiving end of life care	**Intervention**: Patients had access to a BEMOS with a touch screen that allowed patients to navigate the menu and select their meals at any time of the day and place selections up to 1 hour before a meal. The BEMOS enabled patients to select mid-meal options and also included an expanded selection.	**Relevant Outcomes:** - Nutritional intake

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
	Objective: To determine how the implementation of a BEMOS affected dietary intake, plate waste, and meal experience in hospitalized oncology patients	**Number of patients:** 201 (105 in the BEMOS group; 96 in the paper menu group) **Mean age, years (SD)**: 65.0 (NR) in the BEMOS group (range = 18 to 88); 60.5 (NR) in the paper menu group (range = 19 to 93) **Sex**: 47% female in the BEMOS group; 46% female in the paper menu group **Mean weight, kg (SD)**: NR	**Comparator**: Patients used traditional paper menus to select meals. Menus had to be filled our one day in advance. Patients who did not fill out their menu were given a default meal. There were no changes to the menu, foods, recipes, main meal choices, short-order meal alternatives, and nutrient composition of foods between the two cohorts.	
Dijxhoorn, 2018[16] Netherlands	**Study design**: Post-hoc analysis of data collected from a single-centre, prospective pre-post cohort study.[24] The findings of the original study are summarized in the included systematic review.[10] **Setting**: Data from in-patients at an academic hospital in Nijmegen, Netherlands, was collected before (July 2015 to May 2016) and after (January 2016 to December 2016) the hospital transitioned from a traditional model to a "FoodforCare" meal service **Objective**: To investigate	**Inclusion criteria**: Dutch-speaking in-patients (≥ 18 years of age) who had oral intake for at least one full day admitted during the two data collection periods (July 2015 to May 2016 and January 2016 to December 2016) **Excluded**: Patients who were on enteral tube feeding or parenteral nutrition, were unable to adequately answer questions, or who faced language barriers. **Number of patients:** 637 (311 in the "FoodforCare" group; 326 in the traditional service group) **Mean age, years (SD)**: 60 (16) in the "FoodforCare" group; 59 (17) in the traditional service group **Sex**: 55% female in the FoodforCare" group; 51% female in the traditional service	**Intervention**: "FoodforCare" meal service that included six meals per day (three main meals and three in-between meals). Nutritional assistants served the meals at patient bedside and provided advice on meal selection based on individual needs. Patients could ask for additional food and drinks after 7:00 pm. **Comparator**: Traditional meal service that consisted of three meals per day served by nutritional assistants. Small snacks were provided between meals. Patients had access to additional food and	**Relevant Outcomes:** - Protein intake per mealtime

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
	the differences in protein intake at each mealtime as the hospital transitioned from a traditional meal service to a "FoodforCare" meal service	group **Mean weight, kg (SD)**: 78 (17) in the "FoodforCare" group; 79 (17) in the traditional service group	drinks after the schedule meal times.	
McCray, 2018a[17] Australia	**Study design**: Single-centre, retrospective pre-post cohort study using quality assurance data **Setting**: Data from in-patients at the Mater Hospital Brisbane (a 126 bed public acute care adult hospital), Australia, was collected before (August 2014) and after (March 2017) the hospital transitioned from a traditional model to an à la carte room service model **Objective**: To evaluate nutritional intake, plate waste, patient satisfaction, and patient meal costs following the adoption of a room service model in a public adult facility	**Inclusion criteria**: In-patients (≥ 18 years of age) admitted during the data collection periods (August 2014 and March 2017) **Excluded**: Patients who were critically ill, palliative, nil by mouth, younger than 18, restricted to fluids only, on enteral feeding or parenteral nutrition, or did not have a weight recorded or had less than 24 hours of consecutive nutritional intake data **Number of patients:** 187 (103 in the room service group; 84 in the paper menu group) **Mean age, years (SD)**: 70.4 (15.0) in the room service group; 63.4 (19.1) in the paper menu group **Sex**: 52% female in the room service group; 57% female in the paper menu group **Mean weight, kg (SD)**: 72.7 (24.5) in the room service group; 80.3 (24.7) in the paper menu group	**Intervention**: Patients ordered meals from an integrated room service (à la carte style) menu at any point in the day between 6:30 am and 7:00 pm. Meals were delivered within 45 minutes of receiving the order **Comparator**: Meals were ordered using traditional paper menus that were collected by nutritional assistant staff at set times. The menu followed a 14 day cycle and had to be completed up to 24 hours prior to meals. Meals were delivered at set times (breakfast between 6:30 am and 7:30 am; lunch between 11:45 am and 12:45 pm; dinner between 5:00 pm and 6:00 pm)	**Relevant Outcomes:** - Nutritional intake (energy and protein)
McCray, 2018b[18] Australia	**Study design**: Single-centre, retrospective pre-post cohort study using quality assurance data	**Inclusion criteria**: In-patients (≥ 18 years of age) admitted during the data collection periods (August 2014 and July 2016) **Excluded**: Patients who were critically ill,	**Intervention**: Patients ordered their meals using a BSMOS with a hand-held wireless mobile device (Apple iPad). A 7 day cycle	**Relevant Outcomes:** - Nutritional intake

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
	Setting: Data from in-patients at the Mater Hospital Brisbane (a 126 bed public acute care adult hospital), Australia, was collected before and after the hospital transitioned from traditional paper menus to a BSMOS **Objective**: To evaluate the impact of the transition from a paper menu system to a BSMOS on key outcome measures of nutritional intake, plate waste, patient and staff satisfaction, and patient food costs	palliative, nil by mouth, younger than 18, restricted to fluids only, on enteral tube feeding or parenteral nutrition, requested not to participate by patient or nursing staff, or did not have a weight recorded or had less than 24 hours of consecutive nutritional intake data **Number of patients:** 188 (104 in the BSMOS group; 84 in the paper menu group) **Mean age, years (SD)**: 72 (15) in the BSMOS group; 63 (19) in the paper menu group **Sex**: 56% female in the BSMOS group; 57% female in the paper menu group **Mean weight, kg (SD)**: 74 (21) in the BSMOS group; 80 (25) in the paper menu group	menu with more contemporary items was used. **Comparator**: Meals were ordered using traditional paper menus. Menus were filled out in morning to specify a meal for dinner the same day and breakfast and lunch the following day. The menu followed a 14 day cycle.	
Young, 2018[19] Australia	**Study design**: Single-centre, cross-sectional cohort study **Setting**: Data from in-patients at a large publicly funded metropolitan teaching hospital in Brisbane, Australia, was collected using a series of audits over a 4-week period during December 2014. **Objective**: To compare	**Inclusion criteria**: In-patients eating their dinner meal in the ward dining room during the data collection period (December 2014) **Excluded**: Patients who required a texture modified diet or those who ate at the bedside (due to choice or physical impairment) **Number of patients:** 30 (16 in the pre-plated group; 14 in the bistro meal group) **Mean age, years (SD)**: 80.9 (7.6) in the pre-plated group; 76.8 (14.1) in the bistro meal group	**Intervention**: Central pre-plated service. Meals were reheated in bulk and plated in the central kitchen, then transported to the dining hall on a trolley. Menus were filled out in morning to specify lunch and dinner for the same day and breakfast for the following day. **Comparator**: Bistro meal service. Meals were reheated on the ward in a	**Relevant Outcomes:** - Nutritional intake (energy and protein)

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
	central pre-plated and bistro meal services with respect to patient energy and protein intake, patient satisfaction and meal quality.	**Sex**: 50% female in the pre-plated group; 57% female in the bistro meal group **Mean weight, kg (SD)**: NR	Burlodge trolley and were plated in ward kitchen adjacent to the dining room. Patients made their menu selection in advance but had to option to change meal selections at the time of the meal service. All included patients were served in a dining hall and had the same meal options.	
Calleja-Fernández, 2017[20] Spain	**Study design**: Two-centre, cross-sectional cohort study **Setting**: Data from in-patients at two hospitals in the Spanish National Health System was collected between July 2010 and December 2011. One hospital centre (Complejo Asistencial Universitario of León) provided food from a traditional kitchen and the other hospital (Hospital General Universitario Gregorio Marañón Madrid) from a chilled kitchen. **Objective**: To compare the dietary impact of patients served meals from a chilled kitchen versus a traditional kitchen	**Inclusion criteria**: In-patients (≥ 18 years of age) admitted during the data collection periods (July 2010 and December 2011) **Excluded**: Patients who were pregnant, younger than 18, those who were unable to collaborate in the study due to mental disorders or difficulties understanding written language, subjects with a length of stay < 48 hours, patients with eating disorders, those undergoing a weight-loss procedure, and individuals who were admitted to one of the following services: intensive care unit, obstetrics, short-stay unit, paediatrics, emergency department, palliative care, burn unit, and psychiatry. **Number of patients:** 242 (41 in the chilled kitchen group; 201 in the traditional kitchen group) **Mean age, years (SD)**: 74.99 (NR) in the chilled kitchen group; 71.59 (NR) in the traditional kitchen group	**Intervention**: Chilled kitchen system. Meals are chilled following their preparation. They are held in a chilled state until their regeneration prior to consumption by patients. **Comparator**: Traditional kitchen system. Meals were prepared and retained at high temperatures until they are distributed and consumed by patents.	**Relevant Outcomes:** - Nutritional intake

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
		Sex: 24.40% female in the chilled kitchen group; 51.20% female in the traditional kitchen group **Mean weight, kg (SD)**: 57.00 (11.14) in the chilled kitchen group; 68.59 (13.98) in the traditional kitchen group		
Markovski, 2017[21] Australia	**Study design**: Two-centre, prospective observational crossover study **Setting**: Data from elderly in-patients at two sites of Western Health Care Service was collected over a three-month period (July to October 2012). **Objective**: To investigate the effect of midday meal consumption in a communal dining room versus at the patient bedside. Outcomes of interest included on energy and protein consumption and patients' preference.	**Inclusion criteria**: In-patients who had been admitted for < 48 hours and who were motivated to participate in the group, had been behaviorally and socially appropriate in a group setting, and who were medically stable and required limited supervision and assistance. **Excluded**: Patients who required physical assistance to feed, those who were disruptive, antisocial, or aggressive, or those who were medically unstable or had infection control precautions in place. **Number of patients:** 34 **Mean age, years (SD)**: 79.1 (11.8) **Sex**: 74% female **Mean weight, kg (SD)**: NR Note: Patients crossed over from the intervention group to the comparator group; therefore, patient characteristics were identical between the groups.	**Intervention**: "Dining with Friends" program where patients were served their midday meal in a supportive communal dining environment. **Comparator**: Patients were served their midday meal at their bedside. Study participants received their midday meal in the dining room on day 1 and at the bedside on day 2.	**Relevant Outcomes:** - Nutritional intake (energy and protein)
Maunder, 2015[22] Australia	**Study design**: Single-centre, pre-post cohort study	**Inclusion criteria**: Patients admitted to the orthopaedic, orthopaedic rehabilitation, cardiology, oncology, general medical and gynaecology wards during the two weeks	**Intervention**: Patients ordered their meals using a BSMOS. The BSMOS provided patients with	**Relevant Outcomes:** - Nutritional intake (energy and protein)

First Author, Publication Year, Country	Study Design, Setting, Objective	Patient Characteristics	Intervention and Comparator(s)	Clinical Outcomes
	Setting: Data from in-patients at a 210-bed private hospital was collected before (September 2011) and after (November 2012) the hospital transitioned from traditional paper menus to a BSMOS. **Objective**: To determine changes in the dietary intake and satisfaction of in-patients as the hospital implemented an electronic BSMOS compared to paper menus.	of data collection periods (September 2011 and November 2012). **Excluded**: Patients who were admitted to the maternity ward, were nil by mouth, were restricted to fluids only, or who were day stay patients. **Number of patients:** 119 (65 in the BSMOS group; 54 in the paper menu group) **Mean age, years (SD)**: 65 (14) in the BSMOS group; 66 (13) in the paper menu group **Sex**: 59% female in the BSMOS group; 69% female in the paper menu group **Mean weight, kg (SD)**: 79 (18.2) in the BSMOS group; 80 (19.5) in the paper menu group	increased choice of menu items and enabled increased patient/staff interaction throughout the meal ordering process. **Comparator**: Patients used traditional paper menus to select meals. There were no changes to the menu, foods, and recipes between the two cohorts. Menus were filled out in morning to specify a meal for dinner the same day and breakfast and lunch the following day.	

BEMOS = bedside electronic meal ordering system; BSMOS = bedside spoken meal ordering system; NR = not reported; SD = standard deviation.

Appendix 3: Critical Appraisal of Included Publications

Table 5: Strengths and Limitations of the Systematic Review using AMSTAR II[12]

Strengths	Limitations
Dijxhoorn, 2019[10]	
• The objectives and inclusion/exclusion criteria were clearly stated and included components of population, intervention, comparator, and outcomes • Multiple databases were searched (PubMed, Embase, the Cochrane Library, and the Web of Science). In addition, the search was expanded using a snowball search method to identify additional studies. • Key search terms (food service, hospital, menu planning, and hospitalization) and the date of search (December 2, 2017) were provided • The choice of included study designs was justified • Study selection and data extraction processes were described and conducted in duplicate • A flow chart of study selection was provided • A list of included studies was provided and the characteristics of included studies were described in detail • The quality of included studies was assessed in duplicate using the Quality Criteria Checklist for Primary Research (QCCPR) • The risk of bias from the source of funding for the included studies was judged as part of quality assessment • Risk of bias and limitations of primary study methodology were considered when discussing the results • Review authors stated that they had no conflicts of interest related to this review • Sources of funding were disclosed (there was no funding received for this review)	• It is unclear whether the review methods were established prior to conducting the review (no mention of a protocol) • A grey literature search was not completed • A list of excluded studies was not provided (although the reasons for exclusion were) • Studies were excluded if they were not published in the English language, with no justification provided • There was no discussion on the possibility of publication bias • The countries in which relevant primary studies were conducted were not described; the generalizability to the Canadian setting is unclear

QCCPR = Quality Criteria Checklist for Primary Research.

Table 6: Strengths and Limitations of Clinical Studies using the Downs and Black Checklist[13]

Strengths	Limitations
Sathiaraj, 2019[14]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided • Patient inclusion and exclusion criteria were included • Population characteristics (e.g., age, sex) were clearly described and were tested for statistically significant differences at baseline (there were no significant differences between treatment groups) • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different time periods; therefore, a number of uncontrolled factors may have contributed to the findings of the study • Mean baseline body weight or BMI values of patient cohorts were not provided • A power calculation was not reported to determine if the sample was of an adequate size • This study was conducted in hospitals in India; the generalizability to the Canadian setting is unclear

Strengths	Limitations
• Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • Sources of funding were disclosed and were unlikely to have had an effect on the findings of the study • The authors declared that they had no potential conflicts of interest	
Barrington, 2018[15]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided • Patient inclusion and exclusion criteria were included • Population characteristics (e.g., age, sex) were clearly described and were tested for statistically significant differences at baseline (there were no significant differences between treatment groups) • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • The authors declared no funding and that they had no potential conflicts of interest	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different time periods (April 2015 and October 2016); therefore, a number of uncontrolled factors may have contributed to the findings of the study • Mean baseline body weight or BMI values of patient cohorts were not provided • A power calculation was not reported to determine if the sample was of an adequate size • Estimates of random variability were not reported • Single-centre study (conducted in Australia); results may not be generalizable to other centres
Dijxhoorn, 2018[16]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided • Patient inclusion and exclusion criteria were included • Population characteristics (e.g., age, sex, body weight, BMI) were clearly described and were tested for statistically significant differences at baseline • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability were provided • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • The authors declared that they had no potential conflicts of interest	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different time periods (July 2015 to May 2016 and January 2016 to December 2016); therefore, a number of uncontrolled factors may have contributed to the findings of the study • There were significantly more patients with oncologic disease in the “FoodforCare” group and less patients with a MUST score of zero. These were potential confounders that were not adjusted for in the analyses • A power calculation was not reported to determine if the sample was of an adequate size • Actual probability values (*P*-values) were not provided • Sources of funding were disclosed and may have influenced the findings of the study (the study was funded by the FoodforCare Foundation, a group that has ties to the intervention under investigation) • Single-centre study (conducted in the Netherlands); results may not be generalizable to other centres
McCray, 2018a[17]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided (routinely collected quality assurance data from the Mater Hospital	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different time periods (August

Strengths	Limitations
Brisbane) • Patient inclusion and exclusion criteria were included • Population characteristics (e.g., age, sex, body weight) were clearly described and were tested for statistically significant differences at baseline • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • The authors declared no funding for the study	2014 and March 2017); therefore, a number of uncontrolled factors may have contributed to the findings of the study • There were significant differences between intervention cohorts at baseline, including: age, weight, and medical classification • A power calculation was not reported to determine if the sample was of an adequate size • One author acknowledged nonfinancial support from their employer (The CBORD Group, a group that has ties to the intervention under investigation) • Single-centre study (conducted in the Australia); results may not be generalizable to other centres
McCray, 2018b[18]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided (routinely collected quality assurance data from the Mater Hospital Brisbane) • Patient inclusion and exclusion criteria were included • Population characteristics (e.g., age, sex, body weight) were clearly described and were tested for statistically significant differences at baseline • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • The authors declared no funding for the study	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different time periods (August 2014 and July 2016); therefore, a number of uncontrolled factors may have contributed to the findings of the study • There were significant differences in age and medical classification between intervention cohorts at baseline • A power calculation was not reported to determine if the sample was of an adequate size • One author acknowledged nonfinancial support from their employer (The CBORD Group, a group that has ties to the intervention under investigation) • Single-centre study (conducted in the Australia); results may not be generalizable to other centres
Young, 2018[19]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided (a series of audits conducted a 4-week period during December 2014) • Patient inclusion and exclusion criteria were included • Study participants in both intervention cohorts were recruited from the same period of time • Population characteristics (e.g., age, sex) were clearly described and were tested for statistically significant differences at baseline (there were no significant differences between treatment groups) • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Mean baseline body weight or BMI values of patient cohorts were not provided • A power calculation was not reported to determine if the sample was of an adequate size • The source of funding for the study was not disclosed • Single-centre study (conducted in the Australia); results may not be generalizable to other centres

Strengths	Limitations
• The authors declared that they had no potential conflicts of interest	
Calleja-Fernández, 2017[20]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided • Patient inclusion and exclusion criteria were included • Study participants in both intervention cohorts were recruited from the same period of time (between July 2010 and December 2011) • Population characteristics (e.g., age, sex, body weight, BMI) were clearly described and were tested for statistically significant differences at baseline • Sample size calculations were undertaken and the appropriate number of patients recruited (181 estimated vs. 242 recruited) • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • Sources of funding were disclosed and were unlikely to have had an effect on the findings of the study • The authors declared that they had no potential conflicts of interest	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different hospitals (the traditional kitchen cohort from CAULE while the chilled kitchen cohort from HGUGM); therefore, a number of uncontrolled factors may have contributed to the findings of the study • There were significant differences in patient sex between intervention cohorts at baseline • Study was conducted at two hospitals in the Spanish National Health System; results may not be generalizable to other centres
Markovski, 2017[21]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided • Patient inclusion and exclusion criteria were included • Study participants were recruited from the same period of time (between July 2012 and October 2012) • Population characteristics (e.g., age, sex, BMI, malnutrition score) were clearly described • Due to the nature of the study (crossover study), patient characteristics were identical in each intervention arm • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • The authors declared that they had no potential conflicts of interest and that they received no funding or financial grants received for the study	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • A power calculation was not reported to determine if the sample was of an adequate size • All study participants experienced the intervention in the same order (day 1 in the dining room and day 2 at the bedside), creating a risk for bias depending on patient perceptions and expectations • Study was conducted at two sites of Western Health Care Service (Australia); results may not be generalizable to other centres

Strengths	Limitations
Maunder, 2015[22]	
• The objectives, interventions, controls, and main outcomes were clearly described • The data source for the study was provided • Patient inclusion and exclusion criteria were included • Population characteristics (e.g., age, sex, body weight, BMI, mean length of stay) were clearly described and were tested for statistically significant differences at baseline • Main outcome measures were likely accurate • Compliance with the intervention was reliable • The main findings of the study were presented in tabular form and clearly described • Estimates of random variability and actual probability values (*P*-values) were reported • Study participants, care providers, and setting appear to be representative of the population and care setting of interest • Sources of funding were disclosed and were unlikely to have had an effect on the findings of the study	• Intervention assignment was not done at random • This was an open-label study with no blinding of study participants or outcome assessors • Patient cohorts came from two different time periods (September 2011 and November 2012); therefore, a number of uncontrolled factors may have contributed to the findings of the study • A power calculation was not reported to determine if the sample was of an adequate size • There were significant differences in mean length of stay between intervention cohorts at baseline • One author acknowledged nonfinancial support from their employer (The CBORD Group, a group that has ties to the intervention under investigation) • Single-centre study (conducted in the Australia); results may not be generalizable to other centres

BMI = body mass index; CAULE = Complejo Asistencial Universitario of León; HGUGM = Hospital General Universitario Gregorio Marañón of Madrid; MUST = Malnutrition Universal Screening Tool.

Appendix 4: Main Study Findings and Authors' Conclusions

Table 7: Summary of Findings the Included Systematic Review

<table>
<tr><th>Main Study Findings</th><th>Authors' Conclusion</th></tr>
<tr><td colspan="2">Dijxhoorn, 2019[10]</td></tr>
<tr><td>Systematic review that investigated the effects of food service interventions on nutrition and clinical outcomes for in-patients.

Relevant primary studies: The systematic review included 10 relevant primary studies[24-33] that evaluated various food service delivery models. A description of the models examined (interventions and comparators) in each primary study is provided in Table 2. No meta-analysis was conducted; therefore results are summarized individually by primary study.

<table>
<tr><th>Primary study citation</th><th>Summary of relevant findings</th></tr>
<tr><td>Dijxhoorn, 2017[24]
(N = 637)</td><td>- Patients who received food through the "FoodforCare" meal service had higher energy intake relative to requirements on day 1 (88% ± 34% vs. 70% ± 39%; SS; P = NR) and day 4 (84% ± 40% vs. 73% ± 31%; SS; P = NR), and were more likely to fulfill their energy requirements (37% vs. 14%; SS; P = NR) than patients served using traditional meal services
- Patients who received food through the "FoodforCare" meal service had higher protein intake relative to requirements on Day 1 (79 ± 33 vs. 59 ± 28; SS; P = NR) and day 4 (73 ± 38 vs. 59 ± 29; SS; P = NR), and were more likely to fulfill their protein requirements on day 1 (24% vs. 8%; SS; P = NR) and day 4 (23% vs. 8%; SS; P = NR) than patients served using traditional meal services</td></tr>
<tr><td>Doorduijn, 2015[25]
(N = 337)</td><td>- There were no statistically significant (P = NR) differences in energy intake, protein intake, handgrip strength, and body weight between patients in the à la carte cohort compared to those in the traditional meal service cohort</td></tr>
<tr><td>Edwards, 2006[26]
(N = 52)</td><td>- In-patients served using the steamplicity system had increased nutrient intake at lunch (282 g vs. 202 g; SS; P = NR) and dinner (310 g vs. 226 g; SS; P = NR) compared to those served using a cook-chill system</td></tr>
<tr><td>Freil, 2006[27]
(N = 969)</td><td>- There were significant increases in energy intake in the first quartile of patients (i.e., patients who scored in the lowest 25% with respect to energy intake within their treatment cohort) in both individualized meal system cohorts compared to the traditional fixed menu cohort (P = NR). There were no significant differences for the second, third, and fourth quartiles between groups
- Similarly, there were significant increases in protein intake in the first and second quartiles of patients in both individualized meal system cohorts compared to the traditional fixed menu cohort (P = NR). There were no significant differences for the third and fourth quartiles between groups</td></tr>
<tr><td>Goeminne, 2012[28]
(N = 189)</td><td>- In-patients who were served using the meals on wheels system had increased nutrient intake at breakfast, lunch, and dinner by a total of 236 g (95% CI = 163 to 308; P = NR) compared to those served with the standard system</td></tr>
<tr><td>Hickson, 2007[29]
(N = 57)</td><td>- Patients who received meals from the traditional bulk cook-chill system consumed more food (467 g vs. 358 g; SS; P = NR) and had increased energy intake (2,074 kJ vs 1,779 kJ; SS; P = NR) compared to those who received meals from the steamplicity system
- There were no significant differences in protein intake between cohorts</td></tr>
</table>
</td><td>"A concise overview of evidence-based hospital foodservice interventions was created. Based on nine available high-quality studies, we conclude that several types of interventions have the potential to improve outcome measures. These interventions include the use of volunteers to provide mealtime assistance, encouraging patients to choose protein-rich foods, adding protein-enriched items to the menu, replacing existing items with protein-enriched items, ordering food by telephone from a printed menu, or a combination of the above. Health care institutions that wish to improve their foodservice might consider one or more of these interventions."[10] (p. 23)</td></tr>
</table>

Main Study Findings		Authors' Conclusion
Larsen, 2007[30] (N = 113)	- In-patients in the à la carte cohorts had increased fat intake (SS; *P* = NR) and a higher proportion met their daily energy requirements (SS; *P* = NR) compared to those in the traditional meal service cohort - Energy intake did not significantly differ between cohorts (*P* = NR) - Patients in the traditional meal service cohort had increased carbohydrate intake compared to the à la carte groups (SS; *P* = NR)	
McCray, 2017[31] (N = 148)	- In-patients in the à la carte room service cohort had increased daily energy intake (1,588 kcal vs. 1,306 kcal; SS; *P* = NR), daily protein intake (65.9 g vs. 52.3 g; SS; *P* = NR), and had a higher proportion of patients who met their daily energy (75.1% vs. 63.0%; SS; *P* = NR) and protein requirements (84.7% vs. 65.0%; SS; *P* = NR) compared to those who were served with a traditional food service model	
Munk, 2014[32] (N = 84)	- Mean daily protein intake (+9.6 g; SS; *P* = NR) and the proportion of patients fulfilling ≥75% of protein requirements (66% vs. 30%; SS; *P* = NR) were higher in the protein-supplemented food service cohort than in the standard hospital menu cohort - There were no statistically significant (*P* = NR) differences in handgrip strength, length of hospital stay, mean daily energy intake, or in the proportion of patients fulfilling energy requirements between cohorts	
Wilson, 2000[33] (N = 108)	- In-patients served with bulk service had increased daily energy intake (319 kcal vs. 414 kcal; SS; *P* = NR), protein intake (14 g vs. 18 g; SS; *P* = NR), fat intake (11 g vs. 16 g; SS; *P* = NR), and carbohydrate intake(41 g vs. 51 g; SS; *P* = NR) than those who were served with a plated system	

CI = confidence interval; N= number of patients; NR = not reported; SS = statistically significant.

Table 8: Summary of Findings of Included Primary Clinical Studies

Main Study Findings	Authors' Conclusion
Sathiaraj, 2019[14]	
A retrospective, pre-post cohort study (non-randomized) assessing a patient-centered food service model versus a traditional food service model for hospitalized oncology patients. Comparison of patient-centered service model (PC) versus traditional food service model (TF) with respect to several clinical outcomes	"Based on the findings of this study, the patient-centered foodservice model was shown to be effective in significantly increasing foodservice satisfaction among Indian oncology patients. This flexible approach requires the organization and availability of sufficient staff to be able to assist with ordering and serving including co-ordination among the nutritionists, foodservice representatives and chefs. With more informed patients and caregivers and better hospital food service, the incidence of malnutrition can be decreased, and the patient experience improved within the context of oncology hospitals."[14] (p. 422)

Outcome measure	Intervention cohort		Statistical significance (*P*-value)
	PC (N = 100)	TF (N = 160)	
Mean energy intake, kcal (SD)	1633.33 (158.11)	1501.67 (171.22)	<0.01
Mean protein intake, g (SD)	59.89 (10.897)	48.42 (10.794)	<0.01
Mean daily energy intake, kcal/kg/day (SD)	26.85 (3.10)	24.78 (4.38)	<0.01
Mean daily protein intake, g/kg/day (SD)	0.97 (0.15)	0.80 (0.18)	<0.01
Mean in-hospital weight change, kg (SD)	0.18 (0.99)	−0.58 (1.25)	<0.01

N = number of patients; PC = patient-centered service model; SD = standard deviation; TF = traditional food service model.

<table>
<tr><th>Main Study Findings</th><th>Authors' Conclusion</th></tr>
<tr><td colspan="2">Barrington, 2018[15]</td></tr>
<tr><td>A single-centre, observational point prevalence cohort study (non-randomized) that assessed how the implementation of a bedside electronic meal ordering system affected dietary intake, plate waste, and meal experience in hospitalized oncology patients.

Comparison of bedside electronic meal ordering system (BEMOS) versus paper menus (PM) with respect to several clinical outcomes

<table>
<tr><th rowspan="2">Outcome measure</th><th colspan="2">Intervention cohort</th><th rowspan="2">Statistical significance (P-value)</th></tr>
<tr><th>BEMOS (N = 105)</th><th>PM (N = 96)</th></tr>
<tr><td>Mean energy intake, kJ (SD)</td><td>8,683 (4,199)</td><td>6,773 (3,250)</td><td>0.004</td></tr>
<tr><td>Mean protein intake, g (SD)</td><td>72.3 (36.7)</td><td>57.7 (26.9)</td><td><0.001</td></tr>
<tr><td>Mean length of stay, days (SD)</td><td>8.6 (NR)</td><td>9.8 (NR)</td><td>0.59</td></tr>
</table>
BEMOS = bedside electronic meal ordering system; N = number of patients; NR = not reported; PM = paper menus; SD = standard deviation.</td><td>"The results of the present study demonstrate that a patient-directed [BEMOS] can improve patient dietary intake and meal experience by empowering patients to make decisions about their meal selections and nutritional care through easy-to-access meal ordering."[15] (p. 808)</td></tr>
<tr><td colspan="2">Dijxhoorn, 2018[16]</td></tr>
<tr><td>A post-hoc analysis of data collected from a single-centre, prospective pre-post cohort study[24] (non-randomized) that investigated the differences in protein intake of in-patients at each mealtime as a hospital transitioned from a traditional meal service to a "FoodforCare" meal service. Results from the same patient population are described in the included systematic review.[10]

Comparison of "FoodforCare" meal service (FfC) versus traditional meal service (TMS) with respect to several clinical outcomes

<table>
<tr><th rowspan="2">Outcome measure</th><th colspan="2">Intervention cohort</th><th rowspan="2">Statistical significance (P-value)</th></tr>
<tr><th>FfC (N = 311)</th><th>TMS (N = 326)</th></tr>
<tr><td>Median protein intake by meal, g (IQR)</td><td></td><td></td><td></td></tr>
<tr><td>7:30 am</td><td>17 (6.5 to 25.7)</td><td>10 (3.8 to 17)</td><td><0.05</td></tr>
<tr><td>10:00 am</td><td>3.3 (0.3 to 5.3)</td><td>1 (0 to 2.2)</td><td><0.05</td></tr>
<tr><td>12:00 pm</td><td>17.6 (8.4 to 25.8)</td><td>13 (7 to 19.4)</td><td><0.05</td></tr>
<tr><td>2:30 pm</td><td>5.4 (0.8 to 7.5)</td><td>0 (0 to 1.8)</td><td><0.05</td></tr>
<tr><td>5:00 pm</td><td>20.9 (8.4 to 24.1)</td><td>20.5 (10.5 to 27.8)</td><td>NS</td></tr>
<tr><td>7:00 pm</td><td>1 (0 to 3.5)</td><td>0 (0 to 1.7)</td><td><0.05</td></tr>
<tr><td>9:00 pm</td><td>0 (0 to 0.1)</td><td>0 (0 to 0)</td><td><0.05</td></tr>
</table>
FcF = "FoodforCare" meal service; IQR = interquartile range; N = number of patients; NS = non-significant; TMS = traditional meal service.</td><td>"In conclusion, protein intake was highest during the main meals and improved during the in-between meals after implementation of a six times a day hospital food service containing protein-rich meals. Food groups with the highest protein intake per patient were Meat and poultry, Dairy, Cheese and Fish for the [traditional meal service], and Meat and poultry, Cheese, Bread and Fish for the [FoodforCare] service. Several strategies are recommended to optimize food services that might increase the number of patients with adequate protein intake per mealtime and, ultimately, the number of patients achieving their daily individual protein requirements." (p. 7)</td></tr>
<tr><td colspan="2">McCray, 2018a[17]</td></tr>
<tr><td>A single-centre, retrospective, pre-post cohort study (non-randomized) that evaluated the impact of the transition from a traditional paper menu to an integrated room service (à la carte style) menu using quality assurance data.

Comparison of an integrated room service (RS) food service system versus a traditional paper menu system (PM) with respect to several clinical outcomes</td><td>"The redesign of hospital foodservice models is increasingly a focus with respect to not only driving improved patient satisfaction and cost savings, but also influencing clinical outcomes</td></tr>
</table>

Main Study Findings				Authors' Conclusion
Outcome measure	Intervention cohort		Statistical significance (*P*-value)	associated with nutritional intake. Systematically measuring key outcomes associated with improvements in foodservice models allows for a balanced, evidence-based approach to foodservice model evaluation and redesign. This is the first time that a comprehensive measurement of key outcomes has been reported for RS in a public hospital setting. The positive outcomes reported suggest that the RS model offers both clinical and cost benefits important to both patient and organisational outcomes, irrespective of public or private settings."[17] (p. 739)
	RS	PM		
Entire patient population (RS: N = 103; PM N = 84)				
Mean daily energy intake, kJ (SD)	6,379 (2,797)	5,513 (2,112)	0.020	
Mean daily protein intake, g (SD)	73.9 (32.9)	52.9 (23.5)	<0.001	
Proportion of estimated energy requirement met	63.5%	78.0%	0.034	
Proportion of estimated protein requirement met	69.7%	99.0%	<0.001	
Medical patients (RS: N = 49; PM N = 38)				
Mean daily energy intake, kJ (SD)	6,348 (3,026)	5,579 (2,124)	0.186	
Mean daily protein intake, g (SD)	72.7 (35.9)	55.2 (22.0)	0.007	
Proportion of estimated energy requirement met	80.2%	68.2%	0.119	
Proportion of estimated protein requirement met	95.0%	84.9%	0.297	
Oncology patients (RS: N = 26; PM N = 10)				
Mean daily energy intake, kJ (SD)	6,056 (2,742)	5,390 (1985)	0.490	
Mean daily protein intake, g (SD)	68.4 (29.8)	45.8 (22.1)	0.037	
Proportion of estimated energy requirement met	67.0%	58.9%	0.447	
Proportion of estimated protein requirement met	75.9%	49.5%	0.035	
Surgical patients (RS: N = 28; PM N = 36)				
Mean daily energy intake, kJ (SD)	6,733 (2,467)	5,478 (2188)	0.035	
Mean daily protein intake, g (SD)	81.2 (29.6)	52.3 (25.6)	<0.001	
Proportion of estimated energy requirement met	84.6%	59.8%	0.003	
Proportion of estimated protein requirement met	127.5%	59.3%	<0.001	

N = number of patients; PM = traditional paper menu system; RS = room service; SD = standard deviation.

McCray, 2018b[18]	
A single-centre, retrospective, pre-post cohort study (non-randomized) that evaluated the impact of the transition from a traditional paper menu system to a bedside spoken meal ordering system using quality assurance data. Comparison of a bedside spoken meal ordering system (BSMOS) versus a traditional paper menu	"Foodservice model redesign is increasingly being considered in an attempt to improve a range of clinical and organizational measures

Main Study Findings	Authors' Conclusion

system (PM) with respect to several clinical outcomes

Outcome measure	Intervention cohort		Statistical significance (*P*-value)
	BSMOS	PM	
Entire patient population (BSMOS: N = 104; PM N = 84)			
Mean daily energy intake, kJ (SD)	6,232 (2,523)	5,513 (2,112)	0.035
Mean daily protein intake, g (SD)	78 (36)	53 (24)	<0.001
Proportion of patients who achieved their daily energy goal	19%	8%	0.034
Proportion of patients who achieved their daily protein goal	46%	19%	<0.001
Oncology patients (BSMOS: N = 24; PM N = 10)			
Mean daily energy intake, kJ (SD)	6,511 (3,140)	5390 (1,985)	0.222
Mean daily protein intake, g (SD)	75 (37)	46 (22)	0.028
Medical patients (BSMOS: N = 23; PM N = 38)			
Mean daily energy intake, kJ (SD)	5,826 (1,932)	5,579 (2,124)	0.650
Mean daily protein intake, g (SD)	76 (33)	55 (22)	0.011
Surgical patients (BSMOS: N = 57; PM N = 36)			
Mean daily energy intake, kJ (SD)	6,278 (2,468)	5478 (2,188)	0.116
Mean daily protein intake, g (SD)	79 (36)	52 (26)	<0.001

BSMOS = bedside spoken meal ordering system; N = number of patients; PM = traditional paper menu system; SD = standard deviation.

including patient nutritional intake (and therefore nutritional risk), satisfaction, food waste and costs. [BSMOS] utilizes technology to facilitate greater patient engagement and interaction in the meal order process, leading to improved nutritional intake and decreased food waste and costs while maintaining patient satisfaction. The [BSMOS] requires collaboration between food service and clinical nutrition departments to facilitate the foodservice model and process redesign, which can deliver on key outcome drivers for both areas."[18] (p. 70)

Young, 2018[19]

A single-centre, cross-sectional cohort pilot study (non-randomized) that compared a central pre-plated meal service versus a bistro meal service for in-patients eating their dinner meal in the ward dining room.

Comparison of a central pre-plated meal service (PPM) versus a bistro meal service (BM) with respect to several clinical outcomes

Outcome measure	Intervention cohort		Statistical significance (*P*-value)
	PPM (N = 16)	BM (N = 14)	
Mean energy intake, kJ (SD)	2,692 (857)	2,524 (927)	0.612
Mean protein intake, g (SD)	27 (11)	29 (12)	0.699

BM = bistro meal service; N = number of patients; PPM = central pre-plated meal service; SD = standard deviation.

"In conclusion, this pilot quality improvement study found that the food intake of older patients eating in a communal dining room was not higher with a bistro style service compared with a preplated tray service. This suggests that changing only the meal delivery service in a subacute setting without consideration and improvement of other meal access and mealtime experience factors is unlikely to achieve improved nutritional intakes, again confirming the complexity of implementing and evaluating mealtime interventions in health care facilities."[19] (p. 165-166)

<table>
<tr><th>Main Study Findings</th><th>Authors' Conclusion</th></tr>
<tr><td colspan="2">Calleja-Fernández, 2017[20]</td></tr>
<tr><td>A two-centre, cross-sectional cohort study (non-randomized) that aimed to determine the impact that the type of hospital kitchen (chilled versus traditional) has on the dietary intake of in-patients.

Comparison of a chilled kitchen system (CK) versus a traditional kitchen system (TK) with respect to several clinical outcomes

<table>
<tr><th rowspan="2">Outcome measure</th><th colspan="2">Intervention cohort</th><th rowspan="2">Statistical significance (P-value)</th></tr>
<tr><th>CK (N = 41)</th><th>TK (N = 201)</th></tr>
<tr><td>Mean daily energy intake, kcal (IQR)</td><td>1,791.48 (1,194.32)</td><td>1,484.80 (702.3)</td><td>0.002</td></tr>
<tr><td>Mean daily energy intake per patient weight, kcal/kg (SD)</td><td>35.45 (12.16)</td><td>22.41 (9.10)</td><td>>0.05</td></tr>
<tr><td>Mean daily protein intake, g (IQR)</td><td>94.01 (62.67)</td><td>74.85 (47.85)</td><td>0.002</td></tr>
<tr><td>Mean daily protein intake per patient weight, g/kg (SD)</td><td>1.8 (0.66)</td><td>1.05 (0.41)</td><td>>0.05</td></tr>
</table>
CK = chilled kitchen system; IQR = interquartile range; N = number of patients; SD = standard deviation; TK = traditional kitchen system.</td><td>"In conclusion, chilled kitchen systems could increase the energy and protein intake in hospitalized patients in comparison to traditional kitchens, which is particularly necessary for malnourished patients."[20] (p. 415)</td></tr>
<tr><td colspan="2">Markovski, 2017[21]</td></tr>
<tr><td>A two-centre, prospective observational crossover study that investigated the effect of midday meal consumption in a communal dining room versus at the patient bedside.

Comparison of midday meal consumption in a communal dining room (CD) versus at the patient bedside (PB) with respect to several clinical outcomes.

<table>
<tr><th rowspan="2">Outcome measure</th><th colspan="2">Intervention</th><th rowspan="2">Mean difference (95% CI)</th><th rowspan="2">Statistical significance (P-value)</th></tr>
<tr><th>CD</th><th>PB</th></tr>
<tr><td colspan="5">Whole cohort (N = 34)*</td></tr>
<tr><td>Mean energy intake, kJ (SD)</td><td>2,158.3 (813.0)</td><td>1,723.1 (872.8)</td><td>435.2 (136.4 to 734.0)</td><td>0.006</td></tr>
<tr><td>Mean protein intake, g (SD)</td><td>28.2 (13.3)</td><td>22.5 (14.3)</td><td>5.7 (1.3 to 10.2)</td><td>0.01</td></tr>
<tr><td colspan="5">Patients with MST score > 2 (N = 7)*</td></tr>
<tr><td>Mean energy intake, kJ (SD)</td><td>2,295.0 (827.1)</td><td>1,331.0 (830.3)</td><td>964 (−22.3 to 1,950.3)</td><td>0.05</td></tr>
<tr><td>Mean protein intake, g (SD)</td><td>27.3 (11.8)</td><td>19.9 (14.1)</td><td>7.4 (−3.7 to 18.4)</td><td>0.16</td></tr>
<tr><td colspan="5">Patients with BMI < 22 (N = 14)*</td></tr>
<tr><td>Mean energy intake, kJ (SD)</td><td>2,136.6 (794.3)</td><td>1,479.4 (767.9)</td><td>657.2 (165.9 to 1148.4)</td><td>0.01</td></tr>
<tr><td>Mean protein intake, g (SD)</td><td>27.2 (12.32)</td><td>19.0 (12.7)</td><td>8.2 (2.3 to 14.2)</td><td>0.01</td></tr>
<tr><td colspan="5">Patients with MMSE score ≤ 25 (N = 21)*</td></tr>
<tr><td>Mean energy intake, kJ (SD)</td><td>2,213.2 (866.5)</td><td>1,508.1 (889.8)</td><td>705.1 (313.6 to 1,096.6)</td><td>0.001</td></tr>
<tr><td>Mean protein intake, g (SD)</td><td>28.4 (14.2)</td><td>19.9 (13.9)</td><td>8.6 (2.6 to 14.5)</td><td>0.007</td></tr>
<tr><td colspan="5">Patients with poor appetite (N = 8)*</td></tr>
<tr><td>Mean energy intake, kJ (SD)</td><td>1,732.8 (887.8)</td><td>1,290.1 (1,077.0)</td><td>442.7 (−465.0 to 1350.2)</td><td>0.29</td></tr>
</table></td><td>"This pilot study supports using a supervised dining room in geriatric rehabilitation settings to increase the intake of energy and protein, particularly for patients who are underweight or who have significant cognitive impairment. Encouraging patients to attend a supervised dining room can potentially lead to weight gain and improvements in patient nutritional status, facilitate achievement of rehabilitation goals and shorten length of stay; however, further studies are warranted to explore this link further."[21] (p. 228)</td></tr>
</table>

Main Study Findings					Authors' Conclusion
Mean protein intake, g (SD)	24.0 (14.7)	16.6 (14.3)	7.4 (−0.7 to 15.5)	0.07	

*Patients crossed over from the intervention group to the comparator group; therefore, patients were identical between the intervention groups.

BMI = body mass index; CI = confidence interval; CK = chilled kitchen system; MMSE = Mini-Mental State Examination; MST = Malnutrition Screening Tool; N = number of patients; SD = standard deviation; TK = traditional.

Maunder, 2015[22]

A single-centre, pre-post cohort study that measured changes in the dietary intake of in-patients as the hospital implemented an electronic bedside spoken meal ordering system compared to traditional paper menus.

Comparison of a bedside spoken meal ordering system (BSMOS) versus a traditional paper menu system (PM) with respect to several clinical outcomes

Outcome measure	Intervention cohort		Statistical significance (*P*-value)
	BSMOS (N = 286)	PM (N = 242)	
Mean energy intake, kJ (SD)			
Daily total	8,273 (2,043)	6,273 (1,818)	0.000
Breakfast	2,222 (1,116)	1,483 (735)	0.001
Lunch	2,399 (858)	1,684 (565)	0.000
Dinner	2,937 (903)	1,668 (762)	0.000
Mean protein intake, g (SD)			
Daily total	83 (24)	66 (25)	0.001
Breakfast	18 (10)	13 (7.8)	0.007
Lunch	27 (10)	22 (11)	0.028
Dinner	33 (16)	24 (16)	0.009
Mean daily energy goal achieved	110%	86%	0.001
Mean daily protein goal achieved	105%	86%	0.020

BSMOS = bedside spoken meal ordering system; N = number of patients; PM = traditional paper menu system; SD = standard deviation.

"This study reflects the first comprehensive evaluation of the impact of a hospital [BSMOS], demonstrating significant improvements in dietary intake which is associated with improved patient outcomes and LOS. In addition, patient satisfaction, staff satisfaction and dietetic foodservice presence on the wards were noted. There is an enormous potential for hospitals and dietitians to re-orientate services and embrace patient participation through the adoption of [health information technology] to support practice, maximising the efficiency and effectiveness of dietetics care."[22] (p. e138-e139)

BEMOS = bedside electronic meal ordering system; BSMOS = bedside spoken meal ordering system; LOS = length of stay; RS = room service.

Appendix 5: Additional References of Potential Interest

Previous CADTH Reports

Inpatient spoken menus: comparative clinical effectiveness and guidelines. Ottawa (ON): CADTH; 2017 Nov. (CADTH rapid response report: reference list): https://www.cadth.ca/inpatient-spoken-menus-comparative-clinical-effectiveness-and-guidelines-0. Accessed 2019 May 22

Review Articles

Garrubba M, Yap G. Establishing best practice in dining experiences in hospitals: rapid review. Melbourne (AU): Centre for Clinical Effectiveness, Monash Innovation and Quality, Monash Health; 2017: http://monashhealth.org/wp-content/uploads/2019/01/Rapid-Review_Food-experience.pdf. Accessed 2019 May 22